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Structure of upper crust off the Southeast coast of Brazil: Indications for mantle origin of a giant hydrocarbon field

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The southeast coast of Brazil is a passive continental margin whose development is associated with the breakup of the Gondwana during Neocomian times. The crustal structure is characterized by the presence of thick sequences of volcanic layers, reaching up to 15 km in thickness overlying an uplifted mantle segment, as evidenced by depth converted seismic horizons and interpretations of potential field data. The sedimentary cover is relatively thin while layers considered as potential source rocks occur at shallow depths. Significant oil accumulations of hydrocarbons have been encountered in rift sequences, at depths exceeding 6 km, concomitant with or larger than the depths of potential source rocks and with burial times exceeding 80my. Geothermal gradients estimated from bottom-hole temperatures in deep oil wells are in the range of 25 to 35 °C/km and estimated heat flow values are in the range of 60 to 80mW/m^2. Estimates based on palinspastic reconstructions of rift sequences point to thermal maturation indices far exceeding levels of peak generation of oil and gas. The facts that significant oil deposits are found at large depths (> 6km) and at maturation times (>80my) are incompatible with the premises of the model of biogenic origin of petroleum in this region. In this context the alternative model of mantle origin of hydrocarbons have clear advantages. Results of model simulations indicate that mantle rich in hydrocarbons is relatively buoyant and would move to shallow depths in response to isostatic adjustments. Cooling of the exhumed mantle would lead to initial fault bounded subsidence, followed by a later stage of thermal subsidence, a consequence of sequential progression from ductile to brittle deformation. Results of numerical simulations indicate that fracture systems in the exhumed mantle layer may develop during the later stages of thermal subsidence. Such fracture systems with deep circulation of thermal waters are potentially capable of releasing large quantities of hydrocarbons from the exhumed mantle segment. This model of abiogenic origin of petroleum is compatible with the available data on depth levels and geologic times of occurrences of giant hydrocarbon accumulations in the continental margin of Brazil.